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Nutritional value of selected wild edible leaves used by tribal communities of Attappady, Southern Western Ghats

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Abstract
Wild edible plants play a vital role in the food habits of rural and tribal communities across the world and important source of nutrients in the day-to-day life. The present study aims to analyze the nutritional value of selected wild edible leaves used by the tribal communities in Attappady valley of Kerala. It was found that nutritional content of these wild edible leaves are higher than the known vegetables and green leaves. Protein content was found rich and the maximum value is observed in *Leptadenia reticulata*. Selected plants are also rich in Vitamin C which is higher than in the conventional leafy vegetables. Presence of nutrient elements such as calcium and iron is found maximum in *Leptadenia reticulata* and phosphorous in *Diplazium esculentum*. Therefore serious measures are required to conserve these plants as well as to promote consumption of wild edible leaves for keeping better nutrition and health status among tribal communities.

Keywords: wild edibles, ethnobotany, Attappady, tribes, nutrition

Introduction

A wide range of nutrients are required for humans to lead a healthy life. These nutrients can only be derived from a well balanced diet and amount of nutrients required for a person varies with age, gender, physiological status and physical activity. Cereals, millets, fruits, vegetables, meat and milk are considered as main source of nutrients [1]. In many tropical countries, rural people traditionally harvest wide range of leafy vegetables, roots, tubers, fruits from forests and uncultivated lands, because of its taste, availability, for medicinal and cultural use and as supplementary food during lean seasons [2, 3, 4]. Nutritional value of wild edible plants are comparatively less explored but considered as a potential contribution to dietetic diversity and food security of rural communities all over the world [5, 6]. In West African countries, wild edible species play a fundamental role in the survival of populations and a fight against hunger during war and droughts [7]. Wild plants play an important role in the diet of inhabitants of Niger when cereal harvests are inadequate for their consumption. Edible wild plants are also found contributing useful amounts of essential nutrients, including amino acids, fatty acids and trace minerals, to human diets. Majority of women in Vietnam consume large quantities of wild vegetables and many other wild edible species due to its significant contents of micronutrients, calcium and vitamins. In many cases the nutrient qualities are richer in the wild edibles than the cultivated and commercial varieties [8].

Indian subcontinent has about 461 tribal communities which constitute 8.6% of the nation's population and they live across the country in different terrains and forest types [9]. Majority of the tribal communities in India consume over 3900 wild edible species which also serves as a substitute source of food in the time of shortage [10]. A large number of wild plant species as supplementary food has been reported in the "Dictionary of Indian folklore medicine and Ethnobotany" [11]. Tribal communities who live within or on the vicinity of forests depend largely on biomass from wild for their food and energy needs [12, 13]. The dietary habits of tribal communities usually based on their traditional knowledge, culture and seasonal availability of resources. Many wild edible plants used by tribal communities are a great source of proteins and minerals [14]. There has been a growing interest to evaluate various wild edible plants for their nutritional value [15, 16, 17]. But there are still a large number of wild edible species which are consumed by tribal communities whose nutritional potential have not yet been adequately studied. In recent years, due to the changing lifestyle and food habits of tribal households, particularly of younger generation, many prefer modern, main stream dishes ignoring coarse grains and replacing traditional plant-based diet [18]. In the changing context of climate, agricultural practices and consumption pattern, traditional knowledge is often ignored. High levels of anemia and ailments associated with nutrient deficiency were reported from tribal areas across the country. Scientific studies' examining the value of traditional tribal knowledge is hence important in terms of sustainable tribal nutrition as well as global food security. While studies on the nutritional and phytochemical aspects of edible plants are common, the four species taken for analysis here are least explored in such aspects. It is in these contexts, an attempt is made to analyze the nutritive values and other potentials of the four wild edible leaves consumed by tribal communities in the Attappady valley of Kerala Western Ghats.

Materials and Methods

Characteristics of study area

The Southern Western Ghats is considered as one of the world's ten "Hottest Biodiversity Hotspots" as well as a World Heritage site. In addition to its rare, endemic and diverse biotic components, the region harbours many rural and tribal communities as well as a known centre for historical, cultural and social, monuments [19, 20]. Attappady valley is one of the two extensive east sloping plateaus on the Western Ghats of Kerala which covers an area of 745 Km^2 [21]. It is situated in the Palakkad district of Kerala between 10°55'-11°14' N latitude and 76°27'- 76°48' E longitude. The district stands third in total tribal population of Kerala and Attappady itself holds about 56% of tribals in the district [22]. The mean annual rainfall in the valley is 700 to 3000mm, whereas the western region of Attappady receives high rainfall (>3000mm) and eastern region receives rainfall of less than 1000mm. Accordingly the region has a diverse vegetation pattern ranges from West-coast tropical evergreen forests in the high rainfall western part to Southern tropical dry deciduous scrub forests in the north as well as eastern areas [23]. In addition to Tamil and Malayalam speaking settler communities, three different tribal groups, viz. Kurumbas, Irulas and Mudugas are living in 189 settlements across different altitudinal and rainfall zones of Attappady [9]. Communities living in the valley, particularly the tribal groups are known for their knowledge and utilization of plant resources and indigenous medicinal practices [24, 25].

Plant collection and analysis

A survey of wild edible plants and its utilization was conducted during 2013-2015 among selected members and settlements representing the three tribal communities of Attappady valley using ethnobotanical methods [26]. Information gathered on the plants was cross verified with tribal elders. Of the wild edible plant species enlisted, four plants were selected for further understanding of nutritional potential. Even though, until now there are no works or records concern with nutritive and pharmacological aspect in these wild edible plants from Attappady region. Plant species selected for nutritional analysis are organized with botanical name, family, local name and ethnic uses. Fresh leaf samples of *Leptadenia reticulata, Premna corymbosa, Coccinia indica and Diplazium esculentum* was collected during post monsoon season with the help of tribal informants and confirmed the taxonomical identification at Kerala Forest Research institute (KFRI), Thrissur, Kerala (Fig. 1). Leaves were washed thoroughly with distilled water and residual moisture was left to evaporate at room temperature. Parameters such as moisture, protein, crude fibre, crude fat, total ash, total carbohydrate, total sugar, vitamin C, calcium, phosphorous, iron were analyzed using standard procedures [27]. All the analysis was carried out in triplicate samples. To highlight the nutritional importance of wild edible leaves, a comparison of the results made with other known traditional leafy vegetables and commercial fruits.

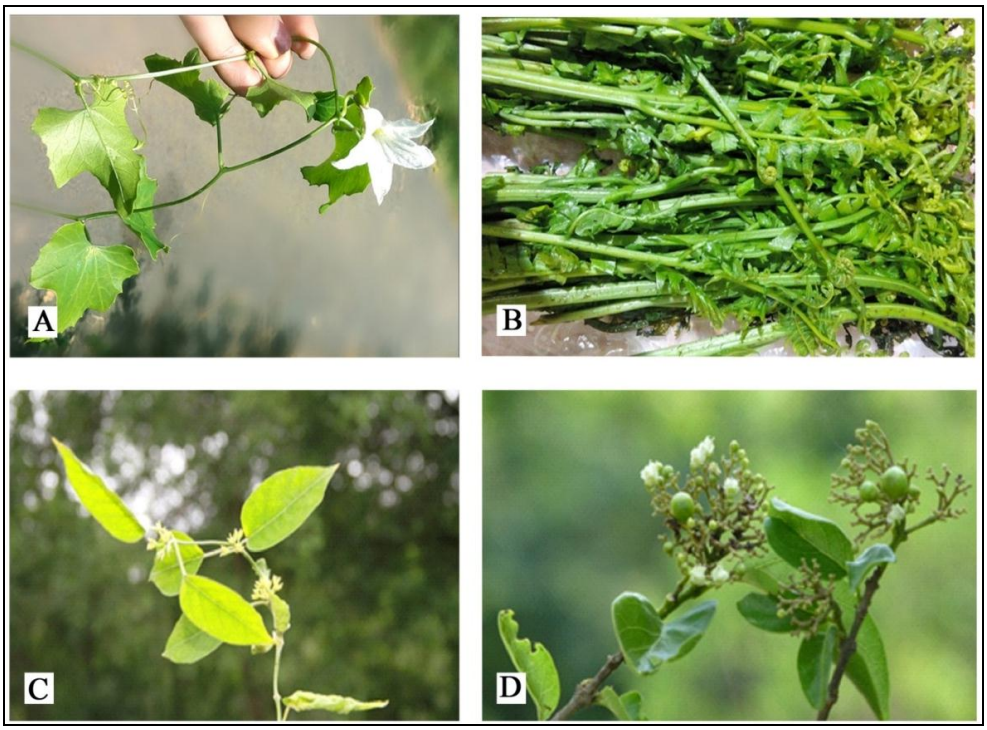

Fig 1: Wild edible plants A. *Coccinia indica* B. *Diplazium esculentum* C. *Leptadenia reticulate*, D. *Premna corymbosa*

Results and Discussion

Ethnobotanical observations

The tribal communities in Attappady valley have rich traditional knowledge of plant species and associated dietary habits utilizing those plants as wild edibles. Leaves of wild edible plants are found to be commonly included in the diet as well as medicinal practices. The plants such as, *Coccinia indica*, *Diplazium esculentum*, *Leptadenia reticulata* and

Premna corymbosa are seasonally available wild edibles of Attappady. Among them *Leptadenia reticulata* and *Premna corymbosa* are used by households for the survival during famine and lean seasons of food grain shortage in Attappady. Ethnobotanical information of selected wild edibles is presented in the Table 1.

Table 1: Ethnobotany of wild edible leaves selected for nutritional analysis

Plant name	Vernacular name	Family	Habit	Edible uses	Medicinal uses
Coccinia indica Wight &Arn.	Thondaidaag	Cucurbitaceae	Climber	Tender leaves are cooked along with lentils	Leaves are used in treatment for ulcer, diabetes
Diplazium esculentum (Retz.) Sw.	Churulai	Athyriaceae	Herb	Both leaves and tender shoots are used for cooking	Leaves and shoot are used in treating whooping cough
Leptadenia reticulata (Retz.) Wight &Arn.	Paaladaag	Asclepiadaceae	Climber	Leaves are cooked with Amaranthus species and other leafy vegetable	Leaves are used in medicinal preparations for the treatment of cancer
Premna corymbosa Rottl.	Munnadaag	Verbenaceae	Shrub	Leaves are cooked along *Amaranthus* species	Leaves are used in medicinal preparations for the treatment of cancer

Coccinia indica **-** is a creeper from the cucurbit family distributed mainly in tropical and sub-tropical regions of the world [28]. In Attappady *C. indica* creepers are found in mid and low rainfall zones, along the farm fences and forest fringes. Many plants from the family cucurbitaceae are known for their usefulness in human health due to its content of acid, vitamins and mineral substances.

Diplazium esculentum **-** is a fern belong to the group Pteridophyte and its tender leaves and shoots are collected for consumption. It is normally found during the monsoon and post monsoon seasons in the wet areas and stream sides. The distribution is throughout Asia and Oceania. It is widely used by village and tribal communities and hence known as Vegetable Fern. Analgesic potential from the plant is also reported [29].

Leptadenia reticulata **-** is a creeper belongs to the family Asclepiadaceae. The genus has distribution from Africa, including Madagascar to India and South-west Asia. In Attappady the plant is found mostly in the Pudur panchayat that falls under the low rainfall zone. The plant is known as "Jivanti" in ayurvedic medicine and is cultivated in some parts of Kerala for use in various ayurvedic formulations considering its stimulant and restorative properties. In some areas it is also used in abortion [30].

Premna corymbosa **-** is a small tree or shrub from the family Verbenaceae, seen in the dry scrub forests and along the borders of fallow lands or agricultural boundaries. The Irula tribals distinguish at least two variants, *Nalla munna* and *Pula munna*, based on the roughness of leaves. The smooth one is preferred for consumption. All *Premna* species are used as ayurvedic drug, generally known as "*agnimantha*" [31].

Usage

Leptadenia reticulata and *Premna corymbosa* are available in the eastern dry regions of Attappady and is mostly collected during post monsoon (August to October) season by Irulas. The ripe fruits of *Coccinia indica* are consumed both by the tribal children as well as frugivore birds. *Diplazium esculentum* is mostly used by the Muduga and Kurumba in the western part receiving high rainfall. The edible leafy shoots of these plants are usually cooked along with lentils and other available *Amaranthus* species. Leaves of *Premna corymbosa* is always cooked in combination with *Amaranthus spinosus* and *Amarathus viridis* to neutralize its bitter taste and strong flavor.

Sometimes these wild edible plants are also used for medicinal purposes. Raw as well as dried leaves of *Leptadenia reticulata* and *Premna corymbosa* are used in the treatment of cancer by tribal healers in the Attappady area. Leaves of *Cocinia indica* is used by the Irula tribes for healing stomach ulcer and to treat diabetes. Tender leaves with shoots of *Diplazium esculentum* is used in treating the whooping cough in children by Irula and Muduga tribes. The medicinal properties and presence of several phytochemicals with strong antioxidant activities in the selected plants were also supported by other studies [32, 33, 34, 35]. Usage of such wild edible leaves in the diet, at least in the available season, improves their health and protects them from various diseases.

Leptadenia reticulata is found to be rare due to over extraction for commercial and medicinal purposes by non-tribal peoples from neighboring villages and towns. Changing landuse patterns in the region, particularly into plantations, commercial farm lands and leased mono-cultural crop lands is also a factor affects the survival of these plants. From the discussions with the tribal informants, it is understood that the availability of the plant is decreasing at an alarming rate and it become scarce to find. *Premna corymbosa* is also a good fodder species mostly preferred by goats. Open rearing of goats is also an important livelihood activity of Irula people in the eastern low rainfall region. In some places, due to excessive grazing of goats, finding the plants for edible and medicinal purposes is difficult. The availability of *Coccinia indica* and *Diplazium esculentum* in the western part is also seems to be decreasing due to increased plantation crops. In such situation plants such as *Coccinia* and *Diplazium* are considered as weeds and destroyed.

Proximate Composition

Proximate values of selected wild edible leaves are presented in the Table 2. It is observed that moisture level of wild edible leaves varies between 71.62% and 86.92% and found maximum in *Coccinia indica* in which values are comparable with *Amaranthus* species ranges from 80 - 88% [36,17]. Moisture content in leafy vegetables is required for hydrolysis process of energy formation in humans and also aid in the digestion of food [37].

Table 2: Proximate value of wild edible leaves

Parameters	*Leptadenia reticulata*	*Premna corymbosa*	*Coccinia indica*	*Diplazium esculentum*
Moisture (%)	83.4±1.21	71.62±1.43	86.92±0.99	85.01±0.20
Total ash %	1.77±0.51	1.92±0.57	1.31±0.46	1.56±0.22
Crude fibre (%)	18.3±3.72	14.3±2.06	10.95±1.65	17.44±4.18
Vitamin C (mg/100g)	29.27±1.94	24.4±1.67	19.5±2.23	24.4± 1.60

Value expressed as mean ± standard deviation

Ash or mineral content is the portion of the food or any organic material that remains after it is burned at very high temperatures and it constitutes several macro and micro minerals. Hence, the ash content is an index of various minerals present in the plants. From the analysis, ash content values in the four selected plants ranges from 1.31 to 1.92% and turned out to be highest in *Premna corymbosa.* These values shown in the plants are comparable with the values reported for some of the known commercial fruits like apple (1.2%), lichi (1.0%), mango ripe (1.1%) and papaya ripe (1.3%) [38].

Crude fibre is a measurement of fibre content and was found more than 10% of fibre content present in all the selected four wild edible leaves. It was found maximum in *Leptadenia reticulata* (18.3%) followed by *Premna corymbosa* (17.44%) which is comparable with the reported value of *Moringa oleifera* (19.25%) [39]. Though the components of crude fibre have little food value it is important for proper peristaltic action in the intestinal tract. Therefore, high fibre content of foods helps in digestion, lowering cholesterol level, weight loss and prevention of colon cancer [40].

Of the four wild edible plants analyzed, all are rich in Vitamin C which ranges between 19.5mg/g and 29.27 mg/100g. Vitamin C content is found to be high in *Leptadenia reticulata* when compared with other common leafy vegetables such as *Moringa Oleifera* (19.30mg/100g) and *Amaranthus viridis* (13.40mg/100g) and even fruits such as jack, sapota and apple [36, 41].

Macronutrients

Macronutrients are energy supplying chemical substances consumed by organisms in large quantities. Carbohydrates, lipids and proteins are the three macronutrients consumed by humans in various forms of nutrition. It is important in maintaining body functions and carry out the activities of daily life. Therefore the amount of macronutrients present in the selected four wild edibles plants was analyzed. The results are given in Table 3.

Table 3: Macronutrients in wild edible leaves

Parameters	*Leptadenia reticulata*	*Premna corymbosa*	*Coccinia indica*	*Diplazium esculentum*
Protein (g/100g)	4.2±0.36	2.7±0.72	4.1±0.26	3.6±0.55
Total carbohydrate (g/100g)	2±0.91	2.2±0.3	1.2±0.1	2±0.43
Crude fat (%)	0.62±0.11	0.74±0.12	0.48±0.13	1.06±0.15
Total sugar (%)	0.67±0.17	ND	1.06±0.03	0.98±0.25

Value expressed as mean ± standard deviation, ND = Non detectable

Proteins are used to produce new tissues for growth and tissue repair and regulate and maintain body functions. Deficiency of protein, can results in under-growth in children and birth of prenatal babies which are the major nutritional concerns among ethnic communities of Africa and Asia [42]. In this study, protein content is found to be high in *Leptadenia reticulata* (4.2 g/100g) and it is comparable with 30 types of green leafy vegetables (0.9 -3.6g/100g) consumed in Southern Karnataka [43].

Total sugar content, total carbohydrate and crude fat was comparatively moderate in selected wild edible leaves when considering cultivated *Amaranth* species [44, 45]. It is important to note that in the leaves of *Premna corymbosa*, sugar content was not fount at a detectable level. Further studies of its potential in pharmaceutical uses like treatment of diabetes may be explored. Except in *Coccinia indica* (1.2 g/100 g), there is only a slight variation in the carbohydrate content among the other three wild edible leaves, ranging from 2 to 2.2 g/100 g (*Premna corymbosa*).

Crude fat refer to the crude mixture of fat-soluble material and is necessary for the maintenance of cellular membranes, which are made from lipids. In the proximate analysis, *Diplazium esculentum* (1.06%) has the highest proportion followed by *Premna corymbosa* (0.74%).

Mineral Composition

Minerals are inorganic chemical elements required as essential nutrients for any organism to perform body functions necessary for life. Among the essential minerals, the important and common ones are Calcium, Potassium, Phosphorus and Magnesium. Wild edible plants contains significant amount of calcium and phosphorous [46]. In the study, Calcium and phosphorous are analyzed from the leaves of four selected wild edible plants (Fig. 2). Calcium content was observed in all the four wild edible plants in ranges between 52 - 98mg. However, it is found high in *Leptadenia reticulata* (98mg/100g) followed by *Coccinia indica* (70.2mg/100g) which is comparatively higher than the value of cultivated vegetable *Moringa oleifera* (67.93mg) [47]. Phosphorous content ranges from 56 to 98.4 mg/100g in which *Diplazium esculentum* has the maximum value. The obtained value of *Diplazium esculentum* (98.4mg/g) is higher than that of the reported values (48- 62 mg/100g) of commonly consumed green leafy vegetables in Assam [36].

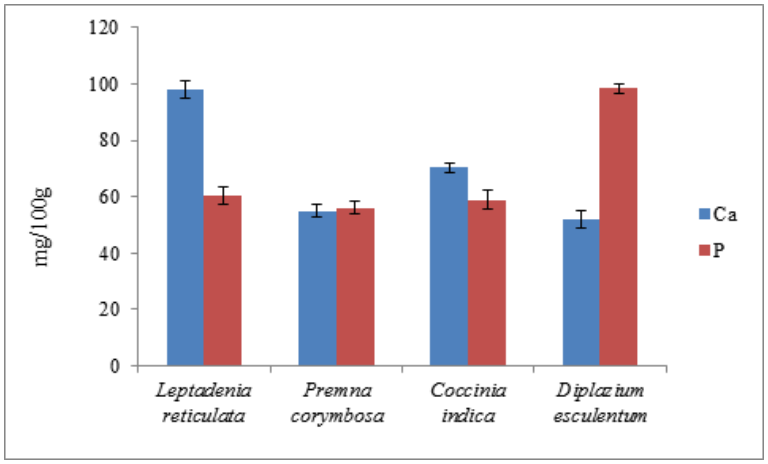

Fig 2: Macromineral contents of wild edibles

Iron is considered as one of the important and essential trace minerals. In the study it is found to be maximum in *Leptadenia reticulata* (6.07mg/100g) that is higher than the leaves of *Colocasia esculenta* (3.82mg) and *Solanum nigrum* (4.76) which are widely consumed as wild edibles by tribal communities in the Wayanad [17] (Fig. 3). Several anemic cases among children and pregnant women are reported from Attappady, due to iron deficiency, during last few years [48]. Hence continuing the consumption of wild edible leaves in their diet, at least seasonally, will helps them to combat health problems associated with iron deficiency.

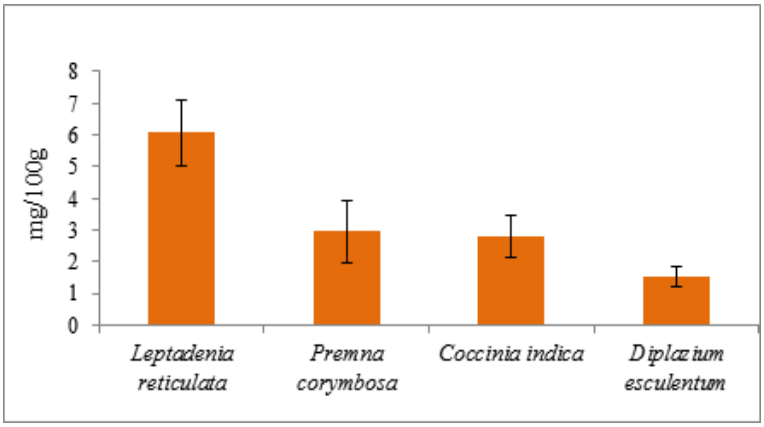

Fig 3: Iron content of wild edibles

Conclusion

From the study of selected wild edible plants it is confirmed that many of the underutilized wild edible leaves forms a good source of nutrients in the dietary practices of tribal communities. It increases the nutritional quality by providing minerals, fiber, vitamins, and essential fatty acids and boost taste and color in diets. Leaves of *Leptadenia reticulata* found to have greater nutritional potential than other wild leaves. Though these wild edible plants are not available year round, they can act as good supplement in diet of tribal communities. And also it can be promoted as well as encouraged into the tribal dietary practices as it is the most practical and sustainable way to prevent diseases and ensure health security of tribal population. Encouraging the consumption of wild edibles would be a sustainable solution to the health and nutritional issues of tribal communities. Conservation of the selected four wild edible plants and their effective propagation techniques should also be considered for wider applications. Further research on other less known wild edible plants in the Attappady area, their nutritional potential and measures for sustainable use would be useful in ensuring food and nutritional security of rural and tribal communities.

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